3GPP TSG-GERAN SAIC Ad-hoc **Tdoc GAHS-030039**
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Source: Nokia

The effect of SAIC terminal penetration on non-SAIC terminal performance

1. Introduction

To date several studies have indicated that SAIC technology has the potential for providing significant benefits. Among these expected benefits are the following:

- With a given amount of system resources, a network is able to support more SAIC mobile terminals than terminals with conventional receivers.
- For a given number of mobile terminals in a network, SAIC mobile terminals experience more user satisfaction in terms of frame error rate than conventional mobile terminals.
- Due to better receiver performance, base stations serving SAIC terminals can use lower power levels. This reduces the overall level of interference in the network, which enables *all* terminals to transmit at lower power levels, reducing the interference in the network even further. This effect helps also the users with non-SAIC terminals as the result in this document show.

There has been some concern that the user satisfaction of conventional mobile terminals may decrease as the penetration of SAIC terminals increases [1]. This contribution addresses this issue and provides evidence that conventional mobile terminals are not adversely affected by the presence of SAIC mobile terminals in the network. On the contrary, also the non-SAIC mobiles benefit from the presence of the SAIC terminals in the network.

2. Simulation setup

Simulations were run using Configuration 3, i.e. assuming 2.4 MHz bandwidth with 12 hopping frequencies (only the hopping layer was simulated). An RxQual/RxLev –based downlink power control algorithm was used [2]. A 65-degree antenna pattern was used since it is more realistic and gives better performance than the 90-degree antenna.

AMR 7.4 codec was used in this study[*]. The call was regarded as successful when its average downlink frame error rate was 0.6%[†] or less. All MSs used DTX. Call dropping was not taken into account, since it was not relevant in this study.

NOTE: The official GERAN interference model was not applied in the link level mapping of these simulations, but the conventional one (one interferer plus noise) since the aim of this study was not to provide absolute capacity gain figures (which are probably slightly optimistic here). A separate contribution will be provided to address the capacity issue [3].

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[*] Default codec in Configuration 4 was AMR5.9. However, we think the 7.4 codec is a better comprimise between capacity and quality. AMR 5.9 is not considered as toll-quality codec and in reality AMR LA would be used and 7.4 codec is a good average of the available codec modes.

[†] This is a tight criteria, but commonly used by AMR speech quality experts

3. Results of the network performance study

The simulation results presented here are intended to shed more light on how the user satisfaction of conventional mobile terminals varies as a function of the number of SAIC mobile terminals in the network. This is shown in Figure 1, where the average proportion of bad quality calls is plotted as a function of effective frequency load.

For comparison, the user satisfaction of SAIC mobile terminals is shown Figure 2, where again the proportion of bad quality call is plotted as a function of effective frequency load.

Figure 3 shows the proportion of bad quality calls averaged over all the mobile terminals in the network. From this figure we can see how much the system capacity increases as the proportion of SAIC terminals in the network increases. Figure 4 shows the system capacity relative to the capacity at 0 % SAIC penetration when the proportion of bad quality calls is 5 %.

The improvement in call quality experienced by conventional terminals is displayed in Figure 5, which gives the decrease in the proportion of bad quality calls compared to the case of 0 % SAIC penetration. We note that the improvement in call quality for conventional terminals is positive for all system loads and increases as the proportion of SAIC terminals increases. However, the improvement diminishes as the system load is increased.

We expect that the overall level of interference in the network decreases as the proportion of SAIC terminals increases. This is confirmed by Figure 6, which shows the burst-level carrier and interference power probability distributions at 5 % and 95 % SAIC penetration when the effective frequency load is 17.3 %. Figure 7 shows that in this case there is also an improvement in the Carrier-to-Interference ratio.

4. Conclusions

The results of our study confirm that as the proportion of SAIC mobile terminals in a network increases, the overall level of interference decreases, leading to improved user satisfaction for both SAIC mobile terminals and non-SAIC mobile terminals. This is due to the quality-based power control that allows base stations to use lower transmission powers for mobiles with better receiver performance. The improvement in user satisfaction is greatest for low system loads, and decreases steadily as the load is increased. In no case does the presence of SAIC terminals in a network degrade the user satisfaction of non-SAIC terminals.

This document provides also useful results about the SAIC capacity gains versus SAIC terminal penetration. The relationship seems to be quite close to linear, but not quite. However, the fact that traditional interference model was used, may distort the relationship somewhat.

5. References

1. 3GPP doc GP-032107, Motorola, "Effect of SAIC terminal penetration on system performance", 25-29 August 2003.
2. "A proposal for common power control algorithm to be used in SAIC network simulations", source Nokia, sent to 3GPP_TSG_GERAN_WG1 list on 29th April, 2003.

3. Tdoc GAHS-030040: "SAIC network capacity with different antenna patterns and performance criteria", source Nokia. 3GPP TSG GERAN SAIC Ad Hoc #3.

Figure 1. Proportion of bad quality calls experienced by non-SAIC mobile terminals.

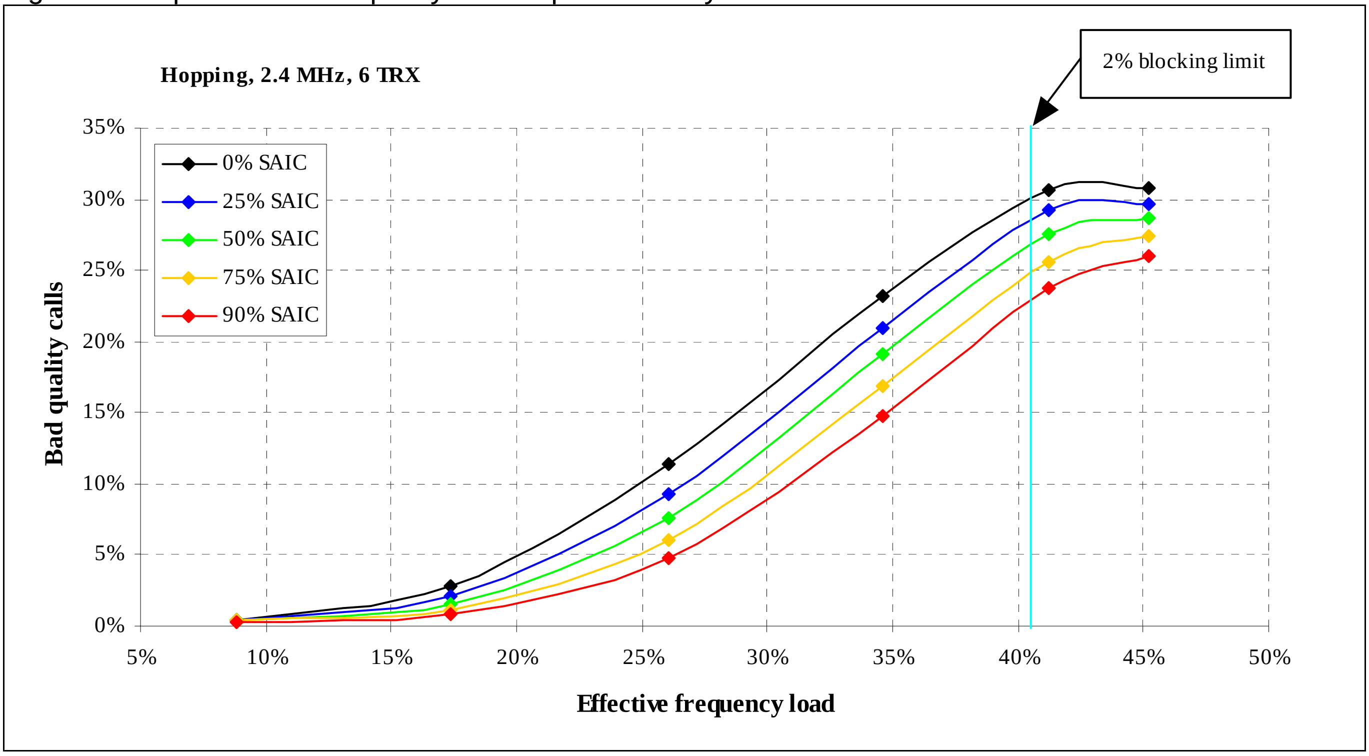

Figure 2. Proportion of bad quality calls experienced by SAIC mobile terminals.

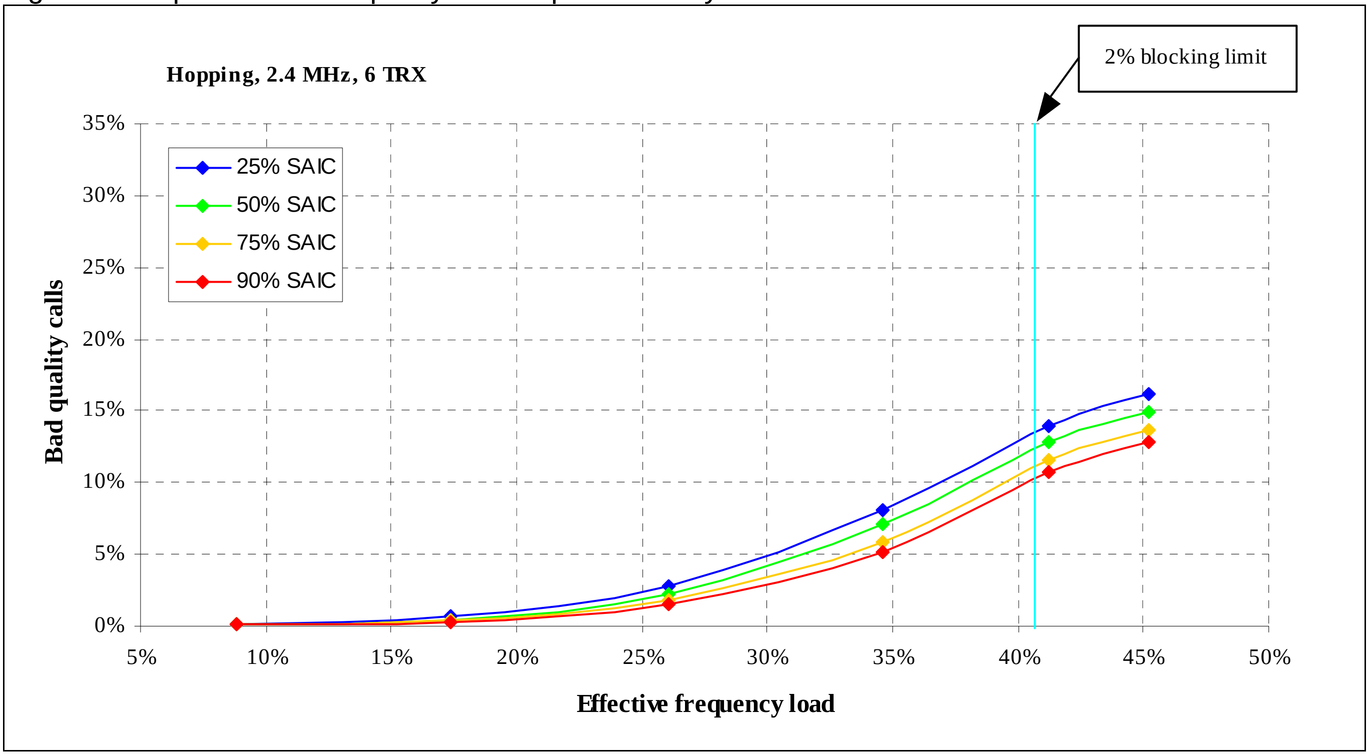

Figure 3. Average proportion of bad quality calls.

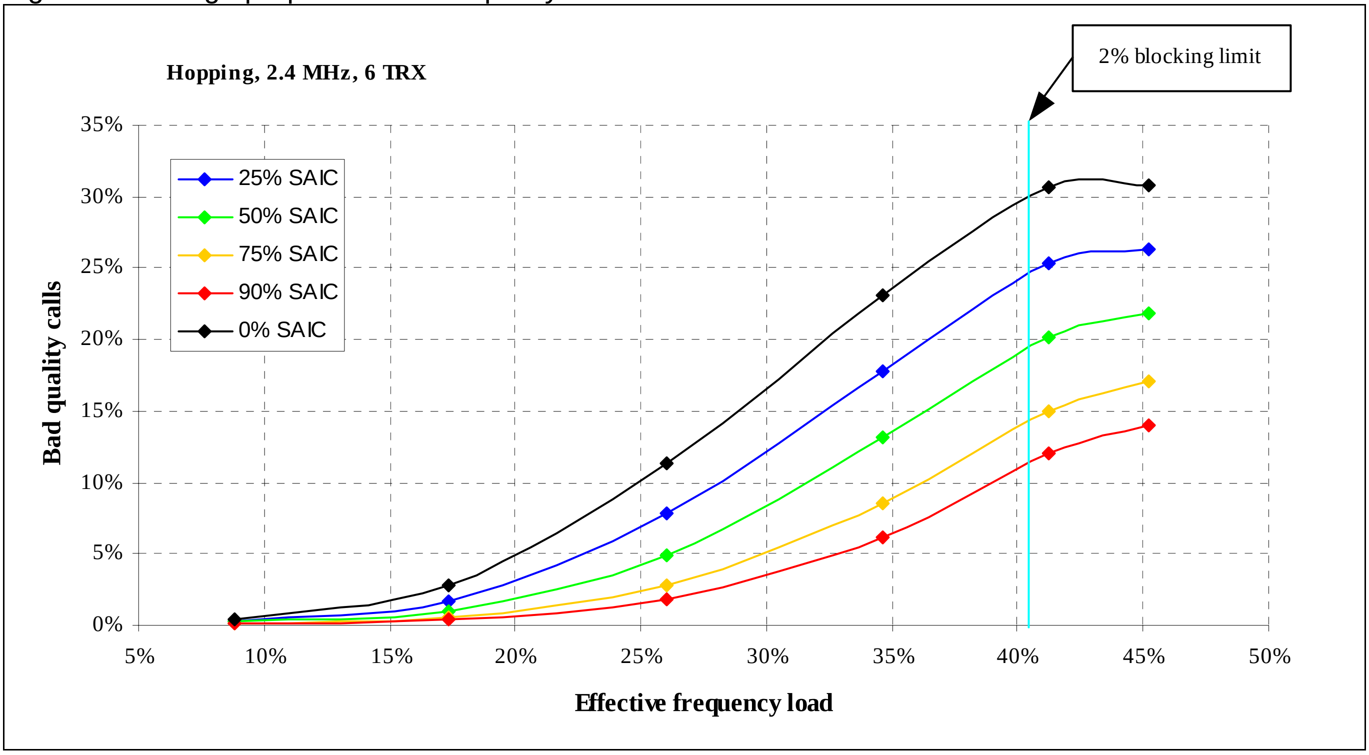

Figure 4. Increase in system capacity (in terms of effective frequency load) as a function of the proportion of SAIC terminals when the proportion of bad quality calls is 5 %.

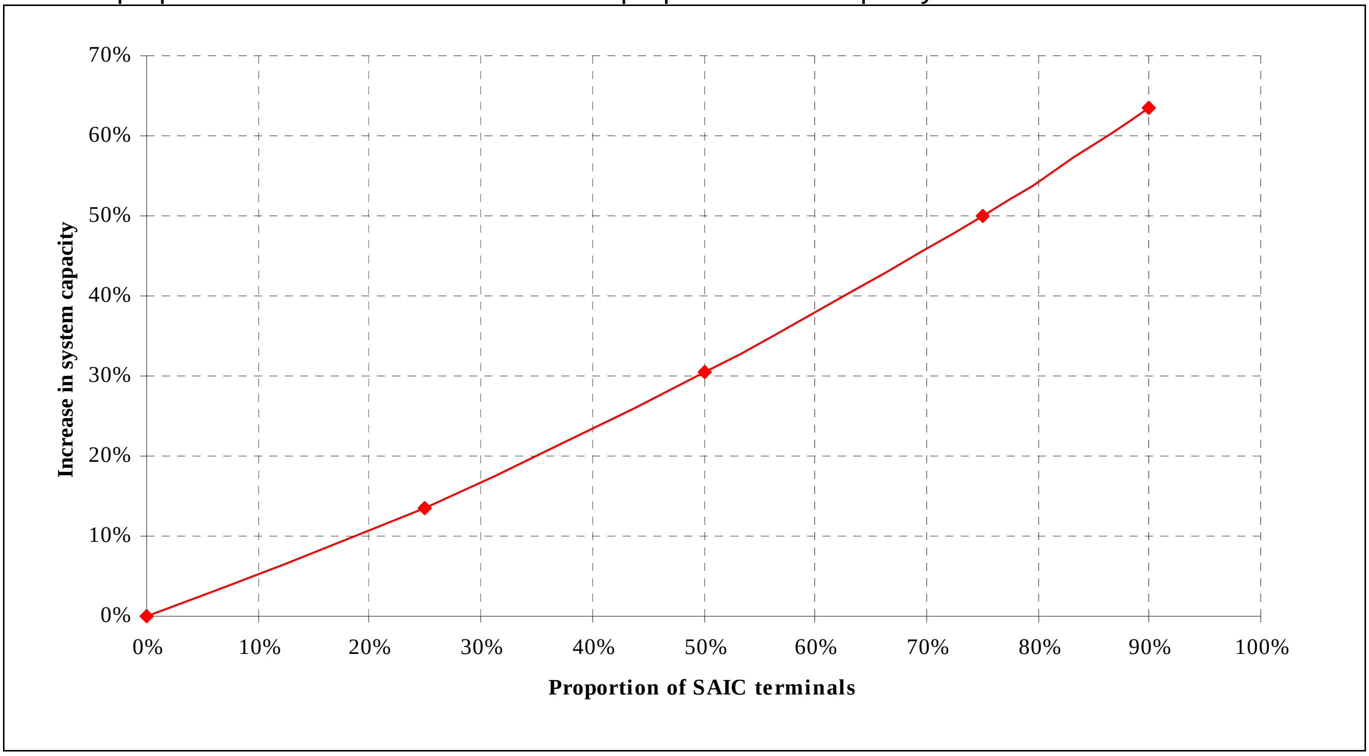

Figure 5. Decrease in the proportion of bad quality calls experienced by non-SAIC terminals as a function of system load.

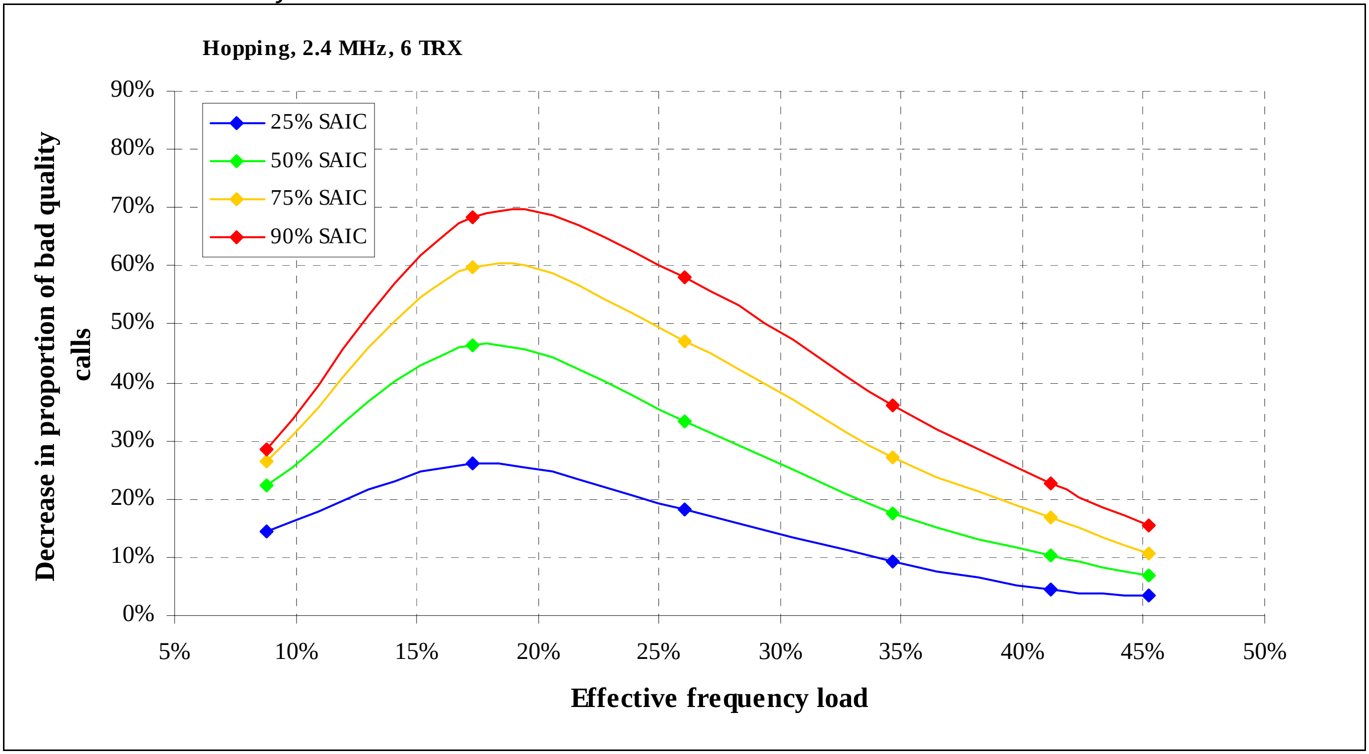

Figure 6. Probability distributions of carrier power and interference power.

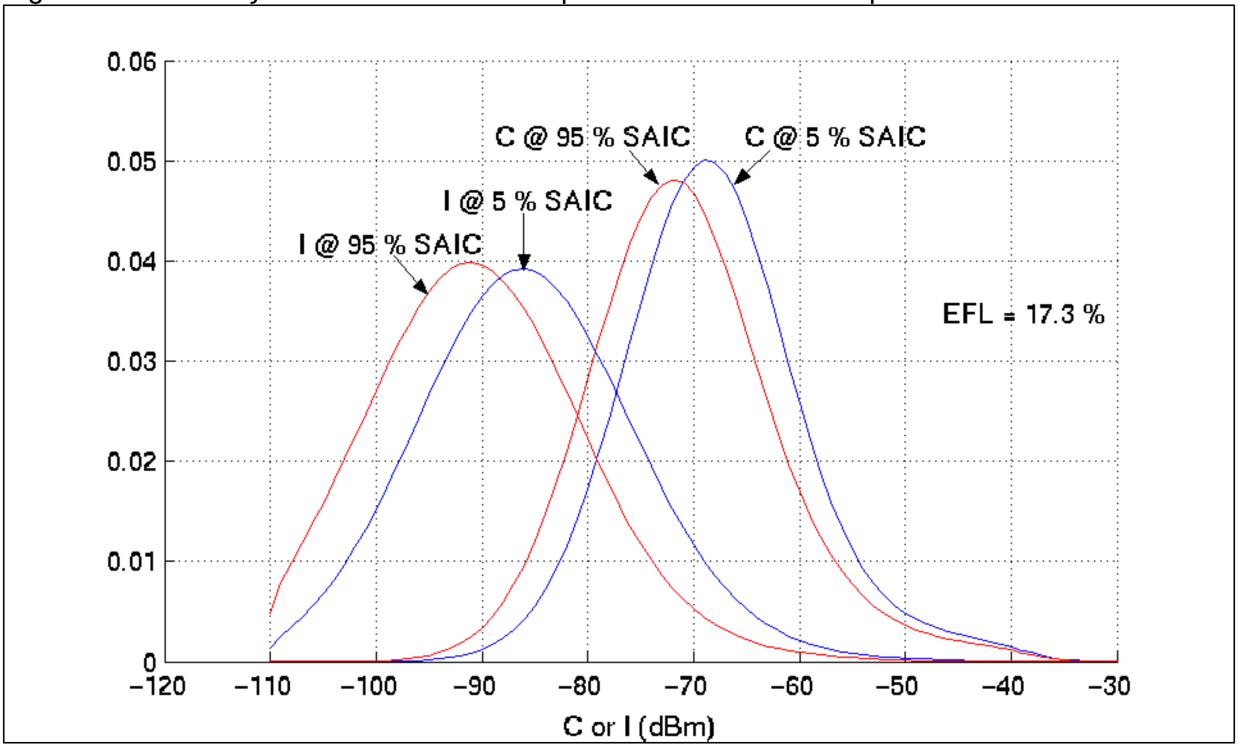

Figure 7. Probability distribution of carrier-to-interference ratio.